Superconducting Detectors for Microwave Astronomy

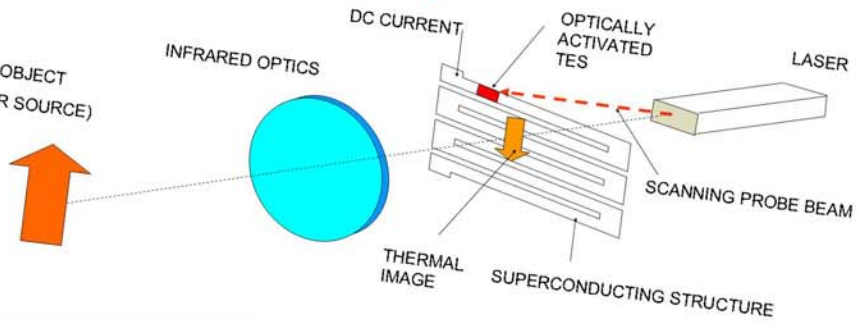
V. Novosad[a], V. Yefremenko[a], R. Divan[b], A. Koshelev[a] , G. Karapetrov[a], J. Pearson[a],
J. Carlstrom[c], C. L. Chang[c], T. M. Crawford[c] , S. S. Meyer[c], K. Miknaitis[c], and J. D. Vieira[c]
[a] Materials Science Division, Argonne National Laboratory
[b] Center for Nanoscale Materials, Argonne National Laboratory
[c] Department of Astronomy and Astrophysics, University of Chicago

Motivation

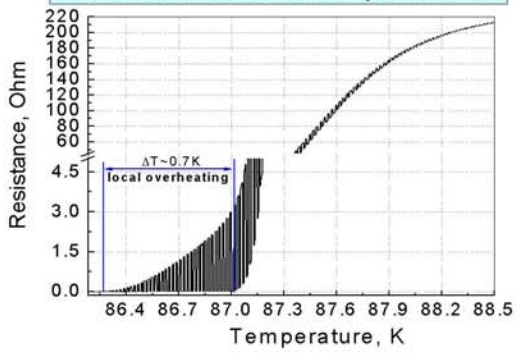
This project is in partnership with the University of Chicago to develop superconducting Transition Edge Sensor (TES) technology for the next generation of Cosmic Microwave Background measurements.

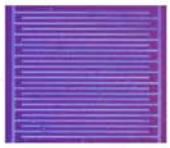
- **New materials and readout approaches are required for further improvement of superconducting detectors.**
- **Improved concepts of antenna-coupled TES devices for polarization sensitive measurements are needed.**
- **Large-area, multiplexed sensor arrays are desirable for CMB measurements, which will provide insight into Cosmic Inflation and Dark Energy.**

Accomplishments



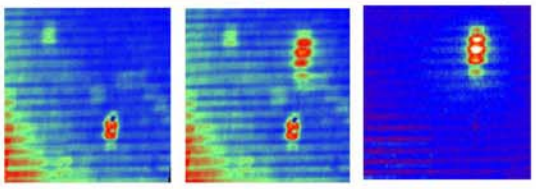
Formation of the sensitive probe area





Lithographically defined YBCO microbolometer array

Detection of IR point source



a) b) c)

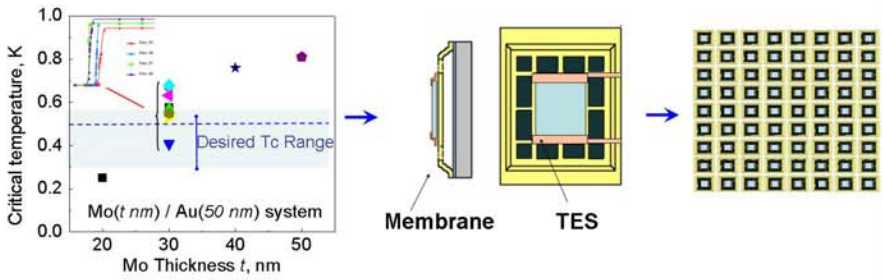
a) background signal (32x32 "effective" pixels array)
b) detected "hot" spot ("*as is*")
c) after background subtraction

- **An optically multiplexed superconducting TES design is demonstrated experimentally. This an alternative approach to Focal Plane Arrays.**

Future Directions

Fabricate and characterize superconducting TES devices at ANL with cryogenic testing and optical measurements at the University of Chicago

- **Control of transition temperature by proximity effects in normal metal / superconductor bilayers and magnetically doped SC films.**
- **Optimize microfabrication process and study noise and electronic transport in suspended single-pixel superconducting TES.**
- **Development of antenna-coupled TES structures with polarization and frequency sensitivity.**
- **Development of large TES arrays with SQUID read-out electronics.**
- **Deploy a polarimeter focal plane on the South Pole Telescope**



Materials Optimization → Single Element Detector → Sensor Arrays

"Improved Method for Detection and Imaging in a Broad Spectral Range", US patent, filed 07/2005.

This work was supported by the U.S. Department of Energy, Basic Energy Sciences, under contract W-31-109-ENG-38.

ARGONNE NATIONAL LABORATORY
THE UNIVERSITY OF CHICAGO
Office of Science U.S. DEPARTMENT OF ENERGY